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Assessment of lifestyle risk factors among cardiovascular disease patients attending Kilimanjaro Christian Medical Centre in Tanzania

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ASSESSMENT OF LIFESTYLE RISK FACTORS AMONG CARDIOVASCULAR DISEASE PATIENTS ATTENDING KILIMANJARO CHRISTIAN MEDICAL CENTRE IN TANZANIA

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ABSTRACT

Cardiovascular diseases (CVDs) have been the leading causes of hospital admissions in Tanzania. Hypertension (HTN) and coronary artery diseases (CHD) are two most common CVDs frequently diagnosed causes of deaths in Tanzanian hospitals. This hospital based-cross-sectional study conducted to assess lifestyle risk factors and levels of biomarkers for CVDs in patients with HTN and CHD attending cardiac clinic at Kilimanjaro Christian Medical Centre-referral hospital. Structured questionnaire was used to assess socio-demographic characteristics and lifestyle risk factors, while anthropometric measurements were taken to assess nutritional status of patients. Blood samples were collected from each patient and analyzed by Cobas Integra and Maglumi analyzers, to detect and quantify concentration of biomarkers. Descriptive statistics were used to analyze socio-demographic, lifestyle risk factors and studied biomarkers for CVDs. Pearson's Chi-Square (χ^2) tests were used to associate risk factors for HTN and CHD while multinomial logistic regression was used to determine independent predictors of HTN and CHD. Majority of the patients (65%) were diagnosed with HTN, and 35% with CHD. The most prevalent risk factors for HTN and CHD were: alcohol intake (67%), high blood pressure (59%), physical inactivity (61%), obesity (39%), alanine aminotransferase (43%), high-density lipoprotein (79%), low-density lipoprotein (65%), C-reactive protein (78%), sodium (41%) and potassium (40%). Moreover, age ($p = 0.007$, CI = 0.047-0.612), plasma glucose ($p = 0.016$, CI = 0.62-0.76), alanine aminotransferase ($p = 0.035$, CI = 0.12-0.93), and C-reactive protein ($p = 0.018$, CI = 0.08-0.79) were independently associated with HTN and CHD. The study affirmed higher exposure of patients to CVDs risk factors despite them being under medical management. The results herein call for sensitization programs, to include more interventions, such as health and nutrition education to raise patients' awareness on lifestyle modifications.

DECLARATION

I, Wilfrida P. Roman, do hereby declare to the Senate of Nelson Mandela African Institution of Science and Technology that this dissertation is my own original work and that it has neither been submitted nor being concurrently submitted for degree award in any other institution.

Wilfrida P. Roman _____ 25-04-2019

Name and signature of candidate **Date**

The above declaration is confirmed:

Dr. Elingarami Sauli _____ 30/4/2019

Name and signature of principal supervisor **Date**

Dr. Haikael D. Martin _____ 29/04/2019

Name and signature of co-supervisor **Date**

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CERTIFICATION

We hereby confirm that the dissertation entitled "Assessment of Lifestyle Risk Factors Among Cardiovascular Disease Patients Attending Kilimanjaro Christian Medical Centre in Tanzania" submitted by Wilfrida P. Roman to The Nelson Mandela African Institution of Science and Technology, Tanzania in partial fulfilment of the requirements for the award of Master's in Life Sciences is an authentic work and has been performed under our supervision.

Dr. Elingarami Sauli _____ 30/4/2019

Name and signature of Principal supervisor **Date**

Dr. Haikael D. Martin _____ 29/04/2019

Name and signature of Co-supervisor **Date**

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DEDICATION

This dissertation is dedicated to all the godsends in my life.

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A LIST OF ABBREVIATIONS

ALT	Alanine Aminotransferase
BMI	Body Mass Index
CAD	Coronary Artery Diseases
CI	Confidence Interval
CVD	Cardiovascular Diseases
CHD	Coronary Heart Diseases
CRP	C-Reactive Protein
HEL	Higher Education Learning
HTN	Hypertension
HDL-C	High-Density Lipoprotein Cholesterol
ISH	International Society Of Hypertension
K	Potassium
KCMC	Kilimanjaro Christian Medical Centre
LDL-C	Low-Density Lipoprotein Cholesterol
Na	Sodium
NE	No Education
NCD	Non-Communicable Diseases
OR	Odds Ratio
OPD	Out-Patient Department
PR	Primary School
WHO	World Health Organization

CHAPTER ONE

INTRODUCTION

1.1 Background information

Cardiovascular diseases (CVDs) are diseases of heart or blood vessels that include coronary artery disease/coronary heart diseases (CAD/CHD), cerebrovascular diseases and peripheral artery diseases (WHO, 2008). Currently, CVDs are regarded as the major cause of overall world mortality and morbidity (Haines *et al.*, 1992), and substantially contribute to the escalating costs of health care (Ngaleison *et al.*, 2017). More than 17.92 million people died in 2015 due to CVDs, with highest death rate of 9.4 million recorded in men and 8.5 million in women, respectively (WHO, 2017a). There is a growing trend of CVD mortality from 16.7 million deaths in 2002 to 17.92 million deaths in 2015, and this is also projected to take lives of 23 million people by 2030 if no measure will be taken to alleviate the problem (Mathers and Loncar, 2005; WHO, 2011; Roth *et al.*, 2017; WHO, 2017). Surprisingly, more than 80% of the deaths from CVDs occur in low-middle income countries and is affecting more than 37% of the aged ≤ 70 years old people (Fuster, 2014; Roth *et al.*, 2017; Keates *et al.*, 2017). More than 40% of premature CVD deaths occurred in low and middle income countries in 2011 and only 4% in high income countries (WHO, 2011). Moreover, CVDs are causing more than 20 million deaths in the African region, with the smallest deaths rates (8.8%) documented in the sub-Saharan region (Moran *et al.*, 2014).

Among all types of CVDs, coronary heart diseases (CHDs) are the leading cause of deaths across all the world regions (WHO, 2011; Gaziono *et al.*, 2011; Onen, 2013; Roth *et al.*, 2015). Of all CVD deaths that occurred in 2015, CHD ranks as the highest cause of deaths, accounting for more than 8.9 million deaths worldwide (Roth *et al.*, 2017). Furthermore, the global projection of mortality and diseases burden predict that world mortality rates due to CHDs will rise by 13.3% in 2015 to 14.1% by 2030 (Mathers and Loncar, 2005). Coronary heart diseases will rise by 70% in men and 74% in women in African regions if there will be no implementation of urgent prevention interventions (Onen, 2013).

The prevalence of CHDs is increasingly uneven in different regions of the world, due to inadequate and poor healthcare services (Gaziono *et al.*, 2011). Both in developed and developing countries, CHDs are considered as a single cause of mortality and morbidity across all gender (Gaziono *et al.*, 2011). Coronary heart diseases were considered to be uncommon in many countries of the Sub-Saharan region (Nkoke and Luchuo, 2015),

however, CHDs are reported to have a significant effect in recent years, with high death rates being reported in the region (Ebireri *et al.*, 2016).

The growing mortality rates due to CHD are highly influenced by the increased levels of blood pressure/hypertension (HTN). Hypertension is one of the leading risk factors for global mortality (accounting for 13% of the total deaths) (WHO, 2009), attributing to more than 45% of all CHD deaths and 51% deaths due to stroke worldwide (WHO, 2013). Untreated HTN results to more health complications, such as myocardial infarction, renal diseases, stoke, heart failure and premature deaths (WHO, 2013), which later increase the cost of treatment and management (Ngalesoni *et al.*, 2015). Treatment of high blood pressure has been associated with a reduction of more than 40% and 16% risks of stroke and myocardial infarction, respectively (Reamy *et al.*, 2007).

The ultimate goal for managing HTN is to achieve target control and prevent the development of other hypertension-related complications (Ross, 2017). As a rule of thumb, the World Health Organization and the International Society for Hypertension recommend management of HTN by monitoring other CVD risk factors, patient-centred lifestyle modification, organ damage and their related clinical signs (WHO/ISH, 2003; WHO, 2014a), rather than relying on taking blood pressure measurement alone. However, the management of hypertension and hypertension related-diseases, including CHDs, usually vary from one country to another as it depends on the country capacity to utilize the available resources for prevention and control of diseases (WHO/ISH, 2003). In high income countries, there is significant reduction of HTN and other CVDs, due to implementation of wide population interventions and strong public policies, such as salt intake reduction, widely accessible diagnosis and treatment methods for HTN, and other risk factors. These have resulted to a 50% reduction of CVD mortality rate in these countries (Danaei *et al.*, 2011). Contrary, CVD risk factors and related diseases seem to increase in developing countries, where there is large number of people suffering from heart attack and stroke due to undiagnosed and uncontrolled CVD risk factors such as HTN (WHO, 2013).

Addressing lifestyle risk factors by raising awareness on healthy eating, regular physical activity, avoiding smoking and alcohol intakes can therefore prevent HTN and hypertension-related diseases (WHO, 2013). Management of lifestyle and intermediate risk factors for CVDs effectively delay or prevent the onset of HTN, and also contribute to reduction of

blood pressure in patients with HTN, and may sometimes also reduce the need for antihypertensive therapy to patients (Anderson *et al.,* 2016; Cléroux *et al.,* 1999).

Regardless of the growing burden of HTN, CHD and their associated risk factors among patients, information on treatment and management progress is insufficient in most of the sub-Saharan countries including Tanzania (Escobar, 2002). The focus of this study was therefore to assess lifestyle risk factors and respective biomarkers (serum lipids, alanine aminotransferase, C-reactive protein, plasma glucose, sodium, and potassium levels) and nutritional status among patients with CVDs attending cardiac clinic at Kilimanjaro Christian Medical Centre referral hospital. These risk factors were then associated with HTN and CHD. Findings from this study will help to improve diagnostic methods, planning, designing and implementing the best preventive interventions.

1.2 Problem statement

Tanzania, like any other developing country, is facing a high burden of non-communicable diseases (NCDs) (Mayige *et al.,* 2012). Non-communicable diseases are affecting 33% of all adults aged 25-64 years in Tanzania, with CVDs accounting for 13% of all deaths (WHO, 2016b). The trend of CVDs in Tanzania among adults aged ≥ 25 years raised from 9%-13% between 2012 and 2016 (WHO, 2014b; WHO, 2016), probably due to the higher prevalence of CVD risk factors (Mayige and Kagaruki, 2013). In the past two decades, CVDs especially CHD, were considered to be uncommon in Tanzania (Kitange *et al.,* 1993; Swai *et al.,*1993). However, findings from current studies showed higher prevalence of these diseases in Tanzania (Edwards *et al.,* 2000; Makubi *et al.,* 2014; Galson *et al.,* 2017). The rates of CVD cases attending Tanzanian hospitals is increasing, posing huge challenges in their treatment and management in primary and secondary healthcare facilities, due to inadequate health care resources (Ngalesoni *et al.,* 2015).

Hypertension and coronary heart diseases are the two most frequently diagnosed CVDs among patients in Tanzanian hospitals (Kisenge, 2011; Peck, 2013; Peck *et al.,* 2014). Hospital-based studies conducted in Tanzania have revealed higher prevalence of HTN and CHD as major public health concerns (Kisenge, 2011). For example, hypertension-related diseases account for 34% of all NCDs deaths, 30% of admission and 28% of all hospital days at Bugando referral hospital from 2009 to 2011 (Peck, 2013). Moreover, Makubi *et al.* (2014) reported a higher prevalence of hypertension (45%) and coronary heart diseases (10%) in a

three years prospective heart failure study conducted at Muhimbili National Hospital from 2012-2013. The growing rates of HTN and CHD observed in Tanzania hospital is highly influenced by the low rate of treatment and poor control of the diseases and their associated risk factors (Peck *et al.,* 2014). A study conducted by Dewhurst *et al.* (2013), observed that, among patients with HTN, only one-sixth (16%) of the patients were under the management of HTN.

Despite the growing burden of these diseases in Tanzanian hospitals, current management practice is highly based on measurements of few risk factors, especially control of blood pressure, blood cholesterol and blood sugar (Makubi *et al.,* 2014). Management of intermediate risk factors should not be monitored alone, but it should include assessment of all other CVD risk factors in a holistic approach, by incorporating patient-centered lifestyle modification (WHO/ISH, 2003). Regular monitoring of lifestyle risk factors, together with intermediate risk factors for HTN and CHD among patients attending cardiac clinics, is an integral part of diseases management, due to its implications on treatment outcomes (WHO, 2013; WHO, 2014a). Proper management of the diseases by addressing all CVD risk factors have significantly contributed to the reduction and prevention of HTN and CHD related mortality (WHO/ISH, 2003). To date, no study had been conducted in Tanzanian hospital settings to evaluate CVD risk factors among patients attending cardiac clinics, to see how they respond to current treatment. Therefore, this study evaluated lifestyle risk factors, intermediate/biomarkers for CVD and their association with HTN and CHD among patients attending a cardiac clinic at KCMC referral hospital in Tanzania.

1.3 Rationale for the study

Determination of most common CVD risks factors, among patients attending cardiac clinic will provide an opportunity for better intervention, prevention and treatment outcome/prognosis. To the best of our knowledge, no study has been conducted in the proposed study area (Kilimanjaro) on associated markers for CVDs, despite presence of research findings that the prevalence of CVD is higher in Kilimanjaro region compared to other regions of Tanzania (Galson *et al.,* 2017). Moreover, most hospital-based studies conducted in Tanzania have always involved a few CVD risk factors (which are known), but no study had been conducted to evaluate the studied risk factors among patients attending cardiac clinics. Findings from this study will improve management of CVDs in Tanzanian hospitals.

1.4 Aim of the study

1.4.1 General objective

The main objective of this study was to assess lifestyle risk factors for CVDS among patients with hypertension and coronary heart diseases at KCMC referral hospital in Tanzania.

1.4.2 Specific objectives

(i) To determine lifestyle risk factors among patients with hypertension and coronary artery diseases attending the cardiac clinic at Kilimanjaro Christian Medical Centre- a referral hospital.

(ii) To determine blood pressure and nutritional status of patients with hypertension and coronary heart diseases.

(iii) To determine the levels of intermediate risk factors/biomarkers (LDL, HDL, ALT, CRP, blood glucose and Na/K) among patients with hypertension and coronary heart diseases.

(iv) To determine the association between studied lifestyle risk factors, their biomarkers, and socio-demographic characteristics among patients with hypertension and coronary heart diseases attending cardiac clinic at Kilimanjaro Christian Medical Centre-a referral hospital.

1.5 Research questions

(i) What are the lifestyle risk factors in patients with hypertension and coronary heart diseases attending KCMC?

(ii) What are the nutritional status and blood pressure levels among the studied patients?

(iii) What are the levels of LDL-C, HDL-C, ALT, CRP, blood glucose and Na/K levels among patients with Hypertension and CHD?

(iv) How LDL and HDL, ALT, CRP, blood glucose Na/K levels, nutritional status, and lifestyle risk factors are associated or pose risk for CVDs among the studied patients?

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview of hypertension and coronary heart diseases

Hypertension accounts for 13% of all deaths globally (Alwan and Armstrong, 2011) and HTN is responsible for 9.4 million deaths each year (WHO, 2013). Worldwide, HTN has attributed to 45% and 51% deaths due to ischemic heart diseases and strokes, respectively (WHO, 2009). Nearly 22% of the world adults in 2014 (> 18 years) were hypertensive (WHO, 2014a). Furthermore, the African region represents higher (46%) prevalence of hypertension compared to high-income countries (35%) (WHO, 2013). According to global projections of diseases, high blood pressure (> 115 mmHg) is estimated to cause 49% of CHD and 62% of stroke deaths (Mackay and Mensah, 2004) if no measures will be taken to alleviate the condition.

The current national STEP survey (2012) showed that 26% of all Tanzanian adults aged 25 to 64 years were hypertensive (Mayige and Kagaruki, 2013). Prevalence of hypertension differs from one region to another and from rural to urban areas. Prevalence of HTN was reported to be 19% in rural areas (32.2% in men and 31.5% in women) and 35% in urban areas (30% in men and 28.6% in women) (Edwards *et al.,* 2000). This might be influenced by sedentary lifestyle and dietary variations for rural to urban dwellers, which include consumption of highly processed food, high salt intake, low consumption of fruits and vegetables. Hypertension is also influenced by high rates of overweight and obesity, that are more prevalent in the urban *(*Bovet *et al.,* 2002; Njelekela *et al.,* 2009). Similar related studies conducted in different regions of Tanzania also reported a higher prevalence of HTN. For example, prevalence of 21.3% among adults aged ≥ 35 years was reported in Manyara among Maasai in 2015 (Mandha *et al.,* 2015), 23.7% in Dar es Salaam (Hendriks *et al.,* 2012), 28% in Kilimanjaro region (Galson *et al.,* 2017), and 44.2% in Mwanza (Mosha *et al.,* 2017). Few hospital-based studies conducted in the country have also shown an increased number of hypertension cases in hospitals (Kisenge, 2011; Peck *et al.,* 2014).

2.2 Pathophysiology of coronary artery disease and hypertension

Pathophysiology of CVDs affects coronary, cerebral or peripheral arteries, and share similar mechanisms that involve atherosclerosis and thrombosis (or clotting). Hypertension is a main risk factor for atherosclerosis, a process that reduces the diameter of the blood vessels

through formation of atherosclerotic plaque in large and medium arteries. Atherosclerosis involves deposition of cholesterols from LDL-C, calcium, inflammatory biomarkers, such as CRP, Liver enzymes such ALT, alanine glyoxylate aminotransferase (AGT) and fibrin (Escobar, 2002; Baguet and Mallion, 2005; Amani and Sharifi, 2005). Reduction in diameter of the coronary arteries by atherosclerotic plaques promotes decreased coronary reserves and myocardial oxygen demand (Escobar, 2002). Over time the unstable plaque eventually ruptures and forms thrombus, which occludes the flow of blood in some parts of the heart, hence causing acute coronary syndromes that result in myocardial ischemia (Baguet and Mallion, 2005).

2.3 Factors that influence development of coronary artery diseases and hypertension

The two diseases, hypertension and CHD have a strong association and share similar risk factors and common pathophysiology (Milane *et al.,* 2014; Weber *et al.,* 2016). Risk factors for the development of HTN and CHD are categorized into non-lifestyle risk factors (age, genetics/ family history), lifestyle risk factors (unhealthy eating, smoking, physical inactivity and alcohol intakes), and intermediate risk factors (raised blood pressure, raised blood cholesterol, diabetes, overweight and obesity). Rapid epidemiological transition and urbanization have been associated with a higher prevalence of these risk factors (Mbewu, 2009; Onen, 2013; Dewhurst and Walker, 2016; Cappuccio and Miller, 2016). Such risk factors have been attributed in causing more than 90% of all deaths occurring in African countries, including Tanzania, and have been linked to socio-economic status and inadequate health services offered in primary and secondary healthcare facilities (Steyn *et al.,* 2005; Belue *et al.,* 2009).

2.3.1 Lifestyle risk factors

Lifestyle/behavioral risk factors are the most common preventable risk factors that underlie the development of CVDs (WHO, 2011). These include unhealthy eating, tobacco use, excessive alcohol intake and physical inactivity. Poor management and prevention of these risk factors can result in metabolic/physiological changes that lead to the development of CVDs (WHO, 2014).

(i) Smoking

Smoking is the leading preventable risk factor for cardiovascular diseases such as ischemic heart disease, cerebrovascular disease and peripheral vascular disease (WHO, 2011;

Wambura and Jamal, 2012). Chemicals present in tobacco (tar, carbon dioxide and nicotine) are associated with increased risk of heart diseases. Nicotine is associated with increased blood pressure and heart rate (Shamshad, 2014). Tar causes damage to the blood vessels and create adverse lipid profile that thicken the blood vessels while carbon dioxide reduces affinity of oxygen to the heart muscles (Shamshad, 2014), causing myocardial infarction. All these contribute to the formation of atherosclerosis and causing a mismatch between the demand and supply for myocardial oxygen and blood to the heart (World heart Federation, 2018).

Worldwide, nearly one billion peoples are current smokers (WHO, 2011a), with more than seven million people dying each year from smoking-related diseases (WHO, 2017c). Of all deaths, 6 million deaths resulted from direct smokers and 890000 deaths from non-smoker/second hand smokers in 2010 (WHO, 2011; WHO, 2017b). According to WHO estimates, annual tobacco-related deaths are anticipated to rise to 8 million by 2030, accounting for 10% of all deaths globally if no appropriate measures will be taken to stop smoking (WHO, 2011b). More than three-quarter of smokers live in low and middle-income countries where the burden of tobacco-related diseases and deaths is also high (WHO, 2017c). For example, the prevalence of tobacco and cigarette smoking among adults in Tanzania is 14.1% for current tobacco smokers, 11.8% for daily tobacco smokers and 9.4% for daily cigarette smokers (WHO, 2017b). Within the country, smoking prevalence also varies from one part of the country to another. Cigarette smoking is very common in Southern zone (31%) and least common in Southern highlands (12%), and this is highly influenced by the low level of education and poor economic status (Kapito-tembo, 2011). Another study conducted in Tanzania by Kidane *et al.* (2015) reported a high prevalence of smoking-related diseases of 41.3% and 8.5% among men and women, respectively. Cessation of tobacco and cigarette smoking has proven to have immediate and long term benefits. The risk for coronary heart disease is about half that of smokers risk after one year of quitting from smoking, and the risk for coronary heart disease is that of a non-smoker after 15 years (World heart Federation, 2018). Health care professionals should therefore actively advice and help patients visiting cardiac clinic to quit from tobacco and cigarette smoking.

(ii) Alcohol consumption

Excessive alcohol consumption is a risk factor for multiple adverse social and health consequences (WHO, 2011a). Harmful use of alcohol is associated with increased risk for

developing various chronic diseases, such as non-communicable diseases, mental and behavioral disorders (WHO, 2014a). The amount of pure alcohol consumption was approximately 6.2 liters per person aged ≥ 15 years globally in 2010 (WHO, 2014b). Average pure alcohol consumption was estimated to be 7.7 liters per person aged ≥ 15 years in Tanzania, which is greater than that of global estimates (WHO, 2014c). Excessive alcohol use is accounting for 3.3 million of the total deaths worldwide (WHO, 2010) and of these deaths, NCDs, especially CVDs and diabetes account for 33.4% (WHO, 2014a). Excessive alcohol consumption increases the CVD risks as it damages the heart muscles, causing increased blood pressure, raised blood cholesterol, increased fibrinolysis and promotion of cardiac arrhythmia (Mukamal, 1995; WHO, 2011). Excessive alcohol intake increases the risk for NCDs, although in large meta-analyses of observational studies regular to light alcohol consumption seems to confer protective effects on coronary heart disease and ischemic stroke (Higashiyama *et al.,* 2013; Bardach, 2017). However, one of the latest Lancet journals has reported that there is no safe level of alcohol intake, any amount of alcohol is linked to increased mortality from NCDs and all other diseases including road traffic accidents (Burton and Sheron, 2018*).*

(iii) Physical activity

Nearly 3.2 million people die from insufficient physical activity each year (WHO, 2011b), with highest death rates marked in women (27%) than in men (20%) (WHO, 2014a). People who engage in physical activity are at lower risk for developing and dying from chronic diseases such as NCDs, including CHD (WHO, 2014). Physically inactive people have 20-30% increased the risk of dying from NCDs compared to physically active people (WHO, 2011b). Low levels of physical activity have been associated with increased CVD risk (Dickie *et al.*, 2014), therefore meeting WHO recommended level of physical activity help to prevent CVD risk factors, such as overweight and obesity, which in turn reduce waist circumference, blood cholesterol, vascular inflammation, finally improving endothelial dysfunction, insulin sensitivity and endogenous fibrinolysis (WHO, 2011; Mashili *et al.,* 2018). Regular physical activity has been proven to reduce risks for CHD by half, helping to prevent stroke and diabetes type 2 (Cléroux *et al.,* 1999; Press *et al.,* 2003).

The level of physical activity varies from rural to urban settings in Tanzania, probably due to various types of work performed by the people in these areas. Higher levels of physical activity ranging from 52-98% and 47-92% have been documented in rural and urban areas of

Tanzania, respectively (Mbalilaki *et al.,* 2007; Mashili *et al.,* 2018). People living in rural areas have higher levels of physical activity compared to urban peoples as they engage in manual and physical works, such as walking a long distance and farming activities (Mandha *et al.,* 2015). Strong evidence exists on the association between regular physical activity, HTN and CHD prevention (Cléroux *et al.,* 1999). Regular physical activity is associated with a reduction of 3.2 mmHg and 2.7 mmHg systolic and diastolic blood pressure, respectively. However, for patients with poorly controlled HTN (systolic ≥ 180 mmHg and diastolic ≥ 100 mmHg), physical exercise should be suspended until their blood pressure is stabilized. It is thus recommended to engage in any physical exercise rather than none (Anderson *et al.,* 2016; Cléroux *et al.,* 1999). In order to improve the overall health and prognosis of patients with CHD, health professionals should therefore, focus more on cardiac rehabilitation and other interventions that help to maintain or increase exercise after CHD diagnosis.

(iv) Unhealthy diet

A healthy diet plays an important role in the prevention of NCDs such as CVDs (WHO, 2016b). Higher consumption of saturated fat, trans-fatty acids, cholesterol and salty foods, with inadequate intake of fruits, vegetables and fish increase the risk for CVD, type 2 diabetes, and cancers (WHO, 2008; WHO, 2010; Eilat-Adar, 2013; Awosan *et al.,* 2014; WHO, 2016). Diet with an adequate amount of fruits and vegetables, mono-unsaturated and polyunsaturated fatty acids, and high in fibers reduces the risk for chronic diseases, including HTN and CHD (Karvonen, 1988).

Globally, nearly 10% of the ischemic heart diseases deaths is attributed to inadequate consumption of fruits and vegetables, with most of the African countries experiencing the double burden of unhealthy eating and malnutrition (underweight and overweight) (WHO, 2016b). On the other hand, higher consumption of salty foods and a diet rich in sodium is an important determinant of hypertension and CVDs (WHO, 2011; WHO, 2012; Tragni *et al.,* 2012). Excessive salt intake (more than 5 g per day) accounted for 1.7 million deaths due to CVD globally in 2010 (WHO, 2014). Based on WHO recommendations, reduction of salt intake to about 1 teaspoon per day help in the prevention of hypertension, heart disease and stroke (WHO, 2016a). A new health planetary diet has been recently by the Lancet Planet Food Commission, recommend a planetary diet rich in plant-based foods and with fewer animal source as it confers both improved health and environmental benefits. Furthermore, a planetary diet should consist of volume of approximately half a plate of vegetables and fruits;

the other half, displayed by contribution to calories, should consist of primarily whole grains, plant protein sources, unsaturated plant oils, and (optionally) modest amounts of animal sources of protein (Willett *et al.*, 2019).

2.3.2 Intermediate risk factors

Intermediate risk factors have a direct link with the NCDs (WHO, 2011). These appear as the results of uncontrolled behavioral risk factors. The key intermediate risk factors for CVDs include: raised blood pressure, diabetes, raised blood cholesterol, overweight and obesity.

(i) Overweight and obesity

Overweight and obesity are among the leading causes of CVD mortality and morbidity (Ahmad, 2012). Overweight is defined as having body mass index (BMI) of 24.9-29.9 kg/m^2 and obesity as a BMI of greater or equal to 30 kg/m^2 (WHO, 2012). Obese individuals have higher risk for diabetes, hypertension, hyperlipidemia, CHD, stroke and certain types of cancer than non-obese (Njelekela *et al.*, 2009; WHO, 2014a). According to WHO estimates, overweight and obesity contribute to 2.6 million deaths from the global disease burden (WHO, 2011a). Both socio-demographic characteristics and economic factors have influence on the causation of overweight and obesity (Shayo and Mugusi, 2011). However, lack of enough statistics, together with socio-cultural beliefs, create greater challenges in understanding the trends of overweight and obesity as public health concerns in African countries including Tanzania (Pangani *et al.*, 2016).

Results from a multi-country cross-sectional study done in 2016 among four Sub-Saharan African countries showed a higher prevalence of overweight and obesity of 46% in rural Uganda, 48% in peri-urban Uganda, 68% in urban Nigeria, 75% in urban Tanzania and 85% in urban South Africa (Ajayi *et al.*, 2016). Another study conducted in Dar es Salaam by Shayo and Mugusi (2011) reported a higher prevalence of obesity (19.2%) that was significantly more prevalent in women (24.7%) than men (9%). Individual perception of body weight is one of the factor that is contributing to the rise of overweight and obesity prevalence in Tanzania. Among individuals who participated in the study conducted by Muhihi *et al.* (2012), only 12% men and 25% women perceived their body weight as being obese compared to overweight, of which 22% men and 38% women perceived themselves as being overweight. Some studies provide evidence on the association between weight loss and reduction in blood pressure and improved glycemic control and reduced CVD risk and all-

cause mortality (Haines *et al.*, 1992; Wing, 2011; Anderson *et al.*, 2016). Weight loss of 5 to 10% was associated with a 5 mmHg decrease in diastolic and systolic blood pressure, 5 mg/dL increase in HDL cholesterol, and 40 mg/dL decrease in triglycerides in another observational analysis study (Wing, 2011). Moreover, evidence from meta-analysis study showed that reduction of 5.1 kg of body weight by means of energy restriction and increased physical activity reduces systolic and diastolic blood pressure by 4.4 mmHg and 3.6 mmHg, respectively (Neter *et al.*, 2003).

(ii) Hypertension

High blood pressure has been acknowledged as one of the strongest risk factors for the development of CVD events, especially coronary heart disease and cerebrovascular diseases, later posing a huge challenge in treatment and management at individual and population level (Olafiranye *et al.*, 2011; WHO, 2012; WHO, 2013). High blood pressure (systolic pressure ≥ 140 mm/Hg and diastolic pressure ≥ 90 mmHg) causes damage of blood vessels that results in increased risks for stroke, heart disease, kidney failure and other hypertension-related diseases (WHO, 2009). Symptoms for raised blood pressure are rarely seen at early stage, hence this may lead to undiagnosed cases and sometimes those who are diagnosed may not have access to treatment, hence increasing hypertension-related diseases to the community (WHO, 2013). Uncontrolled blood pressure can result to more health complications, such as heart diseases, renal diseases (Peck *et al.*, 2014), diabetes (Basimaki, 2013), myocardial infarction, aneurysms, stroke, impaired insulin activities, and premature mortality and morbidity (WHO, 2005; WHO, 2013).

Early detection, treatment and proper management of HTN provide significant health and economic gains to the population (WHO, 2014). Treatment of HTN and hypertension-related complications require costly interventions, such as cardiac bypass surgery, carotid artery surgery and dialysis, which in turn drain individual and government budgets (WHO, 2013). One of the cost-effective intervention towards control of blood pressure is through the implementation of a population-wide intervention that addresses all CVD risk factors as a recommended by WHO (WHO, 2014a). Furthermore, WHO recommends reduction of salt intake to > 5 g/day (2 g/day of sodium), to reduce blood pressure and the related risk for coronary heart diseases and stroke (WHO, 2014a).

(iii) Raised blood cholesterol

In 2008, 38% of the world population had higher blood cholesterol in 2008 (WHO, 2011a). About one-third of all global ischemic heart diseases are caused by higher blood cholesterol (WHO, 2009). The prevalence of raised blood cholesterol was highest (54%) in WHO European region and lowest (23%) in WHO African region in 2008 (WHO, 2009; WHO, 2011a), and this was influenced by rapid urbanization and sedentary lifestyles. According to WHO estimates in 2010, nearly 20% of males and 24% of females in Tanzania had higher blood cholesterol (WHO, 2014b). Kilimanjaro region has been reported with the highest prevalence (17.4% of men and 19% of women) of raised cholesterol compared to Morogoro (5% of men and 6.7% of women), and Mara regions (4.8% of men and 6.9% of women) (Swai *et al.*, 1993). Njelekela *et al.* (2009) reported higher prevalence (48%) of serum triglyceride among study participants, and this was associated with higher prevalence of overweight (33%) obesity (23%) and hypertension (57%).

Diet rich in saturated fats, physical inactivity and genetic factors increase the risk for increased blood cholesterol (WHO, 2009). Higher levels of low-density lipoproteins and low levels of high-density lipoproteins increase the risk for heart diseases and stroke (Mathers and Loncar, 2005), since LDL-C are deposited on the walls of blood vessels, and causes atherosclerosis (WHO, 2011a). Every increase of 1 mmol/L of serum cholesterol is associated with a 40 to 80% increase in CHD risk factors in men (Fracp, 1999). Furthermore, poor dietary diversification contributes to increased blood cholesterol. Study findings showed that a lower intake of fruits and vegetables, with higher intake of red meat, have been linked to increased levels of blood cholesterol (Mandha *et al.*, 2015). For example, higher intakes of coconut oil, palm oil, and meat showed an association with increased blood cholesterol (Njelekela *et al.*, 2003; Katalambula *et al.*, 2017). Lowering of blood cholesterol has been linked to reduced risk for heart disease. For example, a 10% reduction of blood cholesterol resulted in 50% reduction of heart diseases risks in five years follow up study (Woodward *et al.*, 2007). Shifting from using saturated to unsaturated oil, encouraging people to eat at least five servings of fruits and vegetables per day can help to reduce blood cholesterol and CVDs.

(iv) Diabetes

Diabetes is a growing public health problem that presents high cost for its prevention and management by society. Approximately 9% (11% of men and 15% of women) adults aged ≥ 18 years were diabetic globally in 2014 (WHO, 2014a). Dietary change and low level of

physical activity contribute to insulin resistance, which in turn leads to high blood sugar/diabetes (WHO, 2009). Diabetes is causing 6% of the global deaths, with 83% occurring in low and middle-income country (WHO, 2014a). Furthermore, diabetes is attributed to causing more than 22% and 16% deaths due to coronary heart diseases and stroke worldwide, respectively (WHO, 2009).

Prevalence of diabetes varies from one region to another and this depends on availability and country capacity to utilize available few resources in prevention and management of diabetic cases (Bi *et al.,* 2015). According to the International Diabetes Federation (2017) estimates, more than 1.7 million people living in the Sub-Saharan region are diabetic and Tanzania has been mentioned as among of the country with the highest prevalence of diabetes. Results from the current national survey (2012) showed that more than 9% (8% of men and 10% of women) of the adult population aged ≥ 25 years were diabetic (Mayige and Kagaruki, 2013). A large number (5.7%) of diabetic patients in Tanzania lives in urban areas, while few (2%) patients live in rural areas, and men are more affected (3.8%) compared to their counterparts (2.9%) (Aspray *et al.,* 2000). Stanifer *et al.* (2016) documented a prevalence of 21.7% and 5.7% for diabetes and glucose impairment, respectively, among the study population in a study conducted from 2014 to 2015 in Kilimanjaro Region, Tanzania. Diabetes complications are increasing all over the world, and in Sub-Saharan countries, including Tanzania where the disease is becoming a pressing public health concern (Hall *et al.,* 2011). The proportions of diabetic complications in Sub-Saharan region is ranging from 7 to 63% for retinopathy, 27 to 66% for neuropathy, and 10 to 83% for micro-albuminuria (Hall *et al.,* 2011). Similarly, Stanifer *et al.* (2016) documented a large number of patients with diabetic complications, retinopathy (12%), ophthalmic (47%) and neurological disorders (29%) in Tanzania. These complications indicate poor management of diabetes among patients, which need to be addressed. However, lack of diabetic guidelines, screening tools, poor reporting system, inadequate drug therapy and lack of training to health care providers and beneficiaries are among the factors that contribute to the higher prevalence of diabetes, together with its complications (Peck, 2013; Chiwanga *et al.,* 2016; Mwangome *et al.*, 2017). Early detection of diabetic cases and management help to minimize late-stage complications. Furthermore, weight loss and regular physical activity also help to reduce diabetes risk (WHO, 2014a). There is also a need for the continuous provision of healthcare education to diabetes patients in the country, in order to improve access to care and subsequent quality of life.

(v) Alanine aminotransferase

Alanine Aminotransferase (ALT) is a liver enzyme that catalyzes the transfer of amino groups to generate products in gluconeogenesis and amino acid metabolism (Shen *et al.*, 2015). Elevated levels of ALT have been recognized as a marker for liver injury and an overall health indicator (Shen *et al.,* 2015). Elevated serum ALT is mainly attributed to insulin resistance, hypercholesterolemia, hypertriglyceridemia, central obesity (Ioannou *et al.,* 2006), and non-alcoholic fatty liver disease (NAFLD), beside viral hepatitis and excessive drinking (Shen *et al.,* 2015). Both NAFLD and elevated ALT can serve as independent predictors of CHD (Schindhelm *et al.,* 2007).

The link between elevated levels of ALT and CHD is not much clear from most of the studies conducted in different countries. Alanine aminotransferase levels have been used to predict servility of CHD among patients in China, whereby higher levels of ALT (> 42.31±8.34 IU/L) were observed among patients with CHD in control group (18.25±6.38 IU/L) (Shen *et al.,* 2015). Additionally, Ioannou *et al.* (2006) reported increased threshold for CHD in men with higher levels of ALT (> 43 IU/L) than in women (> 30 IU/L) and concluded that patients with higher levels of ALT have increased the risk for calculated CHD risks. In a Framingham Offspring Heart Study participants, both normal and higher levels of ALT were associated with the long-term development of multiple metabolic disorders, and in conclusion, ALT was identified as a potential biomarker for the risk of developing metabolic diseases (Goessling *et al.,* 2008). Higher levels of ALT were also strongly associated with central adiposity, hyperinsulinemia, and hyperleptinemia in the third National Health and Nutrition Examination Survey (NHANES III) (Ruhl and Everharty, 2003).

(vi) C - reactive protein (CRP)

C- reactive protein is an acute phase protein produced by the liver in response to body inflammation. Higher levels of CRP in the blood is highly related to different factors, such as smoking, high blood pressure, and cholesterol, which stimulate inflammatory reactions in the body (Shrivastava, 2015). It plays a key role in many aspects of atherosclerosis process by influencing lipid uptake by macrophage, releasing of pro-inflammatory cytokines, inducing the expression of tissue factors in monocytes, promoting endothelial dysfunction and inhibiting nitric oxide production (Mehta *et al.,* 2007). Furthermore, CRP is well a well-known predictor for the development of CVDs, including coronary heart diseases, myocardial infarction, ischemic stroke, and sudden cardiac death (Amit *et al.,* 2015). For example, Auer

et al. (2002) documented higher levels of CRP of 6.49+/-2.28 mg/L among a group of patients with acute myocardial infarction compared to lower CRP level of 4.35+/-2.6 mg/L among patients with stable coronary artery diseases and their association was strongly significant. In another study, findings showed that patients with higher CRP levels greater than 3 mg/L were at higher risk of dying from CHD than those patients with less than 3 mg/L of CRP levels (Soinio, 2006). However, the role of CPR as an independent predictor of CVD development, especially CHD, was not recognized in other studies (Danesh *et al.,* 2005). Wensley *et al.* (2011) documented that the concentration of CRP alone is unlikely to be a modest causal factor for CHD. There is, therefore, need for conducting mechanistic studies that will come up with a clear understanding of the relationship between CRP and development of CVDs.

(vii) Serum sodium and potassium levels

Maintenance of body electrolytes is of great importance in the management of patients with CVDs and prevention of future health complications from these diseases (Kughapriya and Ponnudhali, 2016). Consumption of dietary sodium and potassium is of public health interests due to homeostasis role played in the body. Serum sodium and potassium represent the internal environment for the body, and play important role in the regulation of blood pressure (Xi *et al.,* 2015b). However, dietary sodium and potassium may not necessarily reflect their level in extracellular fluid (Siani *et al.,* 1987). An increased potassium dietary intake is of great interest primarily due to its association in lowering blood pressure and CVD risks (WHO, 2012). Potassium levels counteract the negative effects of sodium intakes on blood pressure (Mirmiran *et al.,* 2018). Other studies suggest that potassium should not always be evaluated as beneficial in terms of lowering blood pressure, as it has been related with increased risk for hypertension in Chinese population and other populations (Xi *et al.,* 2015a). Excessive consumption of dietary sodium is associated with increased risk factors for CVD, most prominently with raised blood pressure, renal function, left ventricular hypertrophy, and increased arterial stiffness (Xi *et al.,* 2015a). Diet rich in sodium and lower potassium has been identified to contributes to the higher prevalence of CVD risk factors in another study conducted in Tehran-Iran community (Mirmiran *et al.,* 2018). Despite the evidence provided from other previous studies on the relationship between inadequate intake of potassium or excess sodium and increased blood pressure still, there is no clear information on how sodium and potassium are associated with health conditions such as

hypertension and CVD events (Umesawa *et al.*, 2008). These electrolytes are very commonly associated with cardiovascular emergencies, so regular check up on the serum electrolyte levels among patients with coronary heart disease help to improve prognosis among these patients (Kughapriya and Ponnudhali, 2016).

CHAPTER THREE

MATERIALS AND METHODS

3.1 Materials

Neogloves, Syringe with Needle, Microvatte tubes, Eppendorf tube, Vortex mixer, stadiometer, Weighing scale, Automatic digital sphygmomanometer (PB machine), Centrifuge machine (3000 rpm), Cobas integra 400 analyzer plus, Maglumi 800 analyzer, pipette, and blood samples. Detailed information on reagents, equipment and manufactures is attached in Appendices 1 and 2.

3.2 Methods

3.2.1 Study settings

This study was conducted at Kilimanjaro Christian Medical Centre (KCMC)-referral hospital, located in Kilimanjaro region-Tanzania. Kilimanjaro Christian Medical Centre is a referral hospital which serves over 15 million people from the northern, eastern and central zone of Tanzania. The hospital has the capacity to serve 500-800 inpatients per day.

3.2.2 Study design and sampling method

This was a cross-sectional hospital-based study to determine the prevalence of modifiable and intermediate risk factors and their association with CVDs. The study involved outpatients with hypertension and coronary heart diseases attending the cardiac clinic at KCMC-referral hospital. The study was conducted from April to July, 2018. The purpose sampling method was employed to select study participants.

3.2.3 Sample size

The sample size was calculated by using the Kish and Lisle formula for cross-sectional studies adapted from Israel (1992).

$$n = \frac{Z^2\, P(1-P)}{\varepsilon^2}$$

Where: n = minimum required sample size,

p = proportion of patients with cardiovascular disease (9%) (WHO, 2010),

ε = Margin tolerable error (5%),

Z = Standard normal distribution at 5% level of significance (1.96).

$$n = \frac{1.96^2 \times 0.09(1-0.09)}{0.05^2}$$

$n = 100$ Participants.

3.2.4 Inclusion and exclusion criteria

Inclusion criteria: Adults aged ≥ 35 years diagnosed with CHD and HTN who attended the Cardiac clinic at KCMC hospital from April to July, 2018. The study participants voluntarily consented to participate in the study.

Exclusion criteria were: Children (including those with congenital heart diseases) and pregnant women.

3.2.5 Data collection tools

(i) Questionnaire

A structured questionnaire with closed questions was adopted from the WHO STEPwise translated to Swahili language (national language) (Appendix 3). The questionnaire was then administered to all participants. The following information was collected: socio-demographic information, lifestyle risk factors and family history of hypertension and coronary heart diseases. Education level was categorized as primary level, secondary level, higher education learning and uneducated. Marital status (married or unmarried), occupation (formal employment, self-employed and unemployed). Assessed lifestyle risk factors included: current /history of smoking for the past 5 years (classified as Yes or No), present/previous history of alcohol intake (Yes or No), physical activity for at least 2 days per week minimum for 30 minutes (Yes or No), and family history of either hypertension or coronary heart diseases (defined as at least of the close relative (father, mother, sister or brother).

(ii) Anthropometric measurements

Weight in kilogram was taken in light clothing by using calibrated weighing scale machine (Seca, Germany), with 150 kg capacity of accuracy of 0.5 kg. The patients were requested to remain with minimal clothes, removed shoes and excess weight in the pockets before measurements were taken. Height was measured in centimeter (cm) by calibrated Stadiometer

(Leicester stadiometer, Germany) of 0.1 cm accuracy, with the subject standing against the vertical wall, heels together, shoulders and head touching the wall surface and after removal of shoes. Body mass index (BMI) was then calculated by the following formula (BMI = (weight (kg)/(Height (m^2). BMI was categorized as underweight (< 18.5), normal (18.5-24.9), overweight (25-29.9) and obese (≥ 30) (WHO, 2014a).

(iii) Blood pressure measurements

Blood pressure measurement was conducted by the trained clinical officer upon arrival of the patients and after resting for 10-15 minutes. Automatic digital Sphygmomanometer with automatic inflation (Life Brand™ BM60) was used to measure blood pressure while the patient was seated and relaxed with the left hand at the level of the heart. Three systolic and diastolic blood pressure readings were taken on the left upper arm while the patient was seated and relaxed. Average systolic and diastolic blood pressure was used in the analysis. Systolic and diastolic blood pressure measurements were used to classify hypertension in accordance with the Seventh Joint National Committee (SJNC, 2004) (see table 1). Hypertension was confirmed by practicing physicians working at the Out-Patient Department (OPD), using the below table of classification.

Table 1: Classification of blood pressure for adults

	Systolic BP (mmHg)	**Diastolic BP (mmHg)**
Normal	< 120	< 80
Pre-hypertension	120–139	80–89
Hypertension stage –I	140–159	90–99
Hypertension stage-II	≥ 160	≥ 100

(Seventh Joint National Committee, 2004).

Blood sample collection and preparation

Blood samples for plasma glucose, serum ALT, CRP, HDL-C, LDL-C, Na and K concentration measurements were obtained by a trained clinician. Ten (10) ml of venous blood samples were drawn from the arm of each patient and transferred to ethylenediaminetetraacetic acid (EDTA) tube. Blood samples were then taken to a clinical research laboratory at KCMC hospital for further analysis procedures. Blood samples were centrifuged at the 3000 rpm machine (German) for 5 minutes at 4 °C. Clarified serum and plasma samples were then pipetted and poured into Eppendorf storage tubes (5 mls), followed by freezing at -20 °C.

(iv) Laboratory analysis of biomarkers

Before analysis, plasma and serum blood samples were mixed thoroughly by using vortex mixer. Form each sample 10 μL were pipetted and poured into Microvatte tubes. Plasma blood glucose, HLD-C, LDL-C, ALT, Na, and K samples were loaded into Cobas Integra 400 plus analyzer (Roche Diagnostics, Germany). Serum blood for measuring CRP concentration was loaded into fully-auto chemiluminescence immunoassay (CLIA) analyzer (MAGLUMI 800) Shenzhen New Industries Biomedical Engineering Co., Ltd (Snibe Diagnostic), China. According to laboratory protocols, values (concentrations) of studied biochemistry markers were categorized as indicated in Table 2.

Table 2: Classification of biochemical markers

Biomarkers	**Descriptor**
Plasma glucose	
3.5-6.5	Normal
> 6.5	Hyperglycemia/diabetes
HDL-C (mmol/L)	
> 1.45- > 1.68	Normal
0.90-1.68	Moderate risk
0.90- < 1.15	High risk
LDL-C (mmol/L)	
< 2.59-3.34	Normal
> 3.34- ≥ 4.92	High risk
ALT (IU/L)	
< 31	Normal- male
< 19	Normal- female
> 31	High risk - male
> 19	High risk-female
Sodium (mmol/L)	
136-145	Normal
> 145	High
Potassium (mmol/L)	
3.50 - 5.10	Normal
> 5.10	High
CRP (mmol/L)	
< 1	Normal
1-3	Moderate risk
> 3	High risk

NOTE: HDL-C, high-density lipoprotein cholesterol, LDL-C, Low-density lipoprotein cholesterol, ALT, alanine aminotransferase, CRP, C-reactive protein

3.3 Statistical analysis

Data were entered in into Microsoft Excel 2013, and then sorted, coded, and cleaned. The analysis was done using SPSS version 20.0 (IBM). Descriptive statistics were used to analyze the frequency and percentages of socio-demographics, lifestyle characteristics, and biomarkers for HTN and CHD. Pearson's Chi-Square (χ^2) test was used to determine the association between risk factors with HTN and CHD. Independent variables included in the

analysis were: gender, age, education level, occupation, marital status, BMI, blood pressure, physical activity, smoking history, alcohol consumption, plasma blood sugar, ALT, HDL-C, LDL-C, CRP, Na and K levels. Independent variables significantly associated with HTN and CHD in Pearson's Chi-square test were subjected to multinomial logistic regression analysis model to reveal potential risk for HTN and CHD. Upon building the final model only variables which were statistically associated with HTN and CHD were included. Statistical significance was tested at 95% confidence interval (alpha ≤ 0.05).

3.4 Ethical clearance and informed consent

This study was approved by ethics committee from Tanzania National Institute for Medical Research (NIMR) (NIMR/HQ/R.8a/Vol.IX/2737) and from Kilimanjaro Christian Medical Centre-referral hospital. Participants were well informed about the aim of the study. Written informed consents were obtained from those who agreed to participate.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Results

4.1.1 General characteristics of the population

A total of 100 patients with HTN and CHDs who attended the cardiac clinic at Kilimanjaro Christian Medical Centre (KCMC) referral hospital between April to July, 2018 were recruited and consented to participate in this study. Socio-demographic characteristics of the patients were as summarized in Table 3. Out of 100 patients, 31% were males and 69 were females. Majority of the patients were educated, with 45% primary education, 32% secondary education, and 14% higher education (college and university), while only 9% had no formal education. More than three-quarter (81%) of the patients were within the age category of 45 years and above, while only 19% were below 45 years. Seventy-three percent of the patients were married and 27% had no partner. Most of the patients (72%) were self-employed, 15% had formal employment, and 13% had no formal employment. Furthermore, results showed that 53% of the patients had a family history of hypertension and coronary heart diseases, and more one-third of the patient were using alternative medicine/herbal medicine to treat the disease.

Table 3: Socio-demographic characteristics of participants

Variables	Frequency (N=100)	Percentage (100%)
Gender		
Men	31	31
Women	69	69
Age		
<45	19	19
>45	81	81
Education level		
Higher education learning	14	
Primary level	45	14
Secondary level	32	45
No formal education	9	32
Marital status		
Married	73	73
No partner	27	27
Occupation		
Formal-employment	15	15
Self-employed	72	72
Unemployed	13	13
Family history		
Yes	53	53
No	47	47
Types of other chronic diseases		
Chronic kidney diseases	11	25
Arthritis	7	15.9
Diabetes	15	34.1
Stomach ulcers	9	20.5
Valve failure	2	4.5
Herbal medicine		
Yes	36	36
No	64	64

4.1.2 Percentage of the patients diagnosed with hypertension and coronary heart diseases

Results presented in Fig. 1 shows types of CVDs which were clinically diagnosed from the study patients. Sixty-five percent of the patients were hypertensive, and 35% suffering from coronary heart diseases.

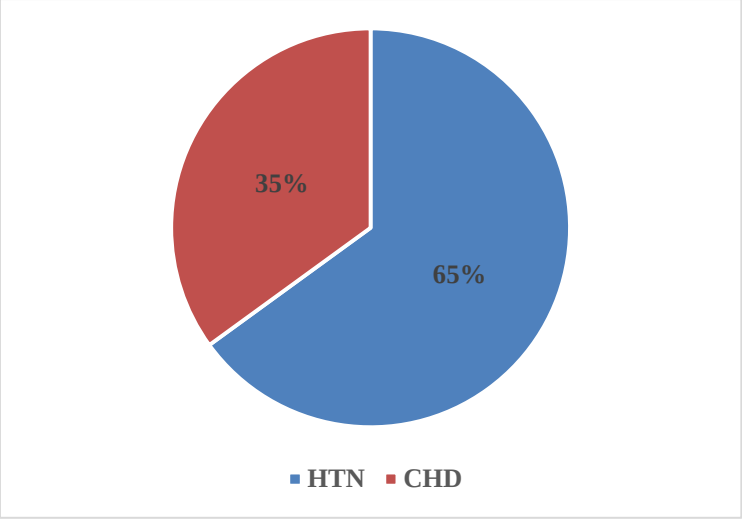

Figure 1: Percent of patients diagnosed with hypertension and coronary heart disease

4.1.3 Proportion of lifestyle risk factors among study patients

(i) Lifestyle risk factors

The proportion of lifestyle risk factors for hypertension and coronary heart diseases assessed from each patient participated in this study is summarized in Fig. 2. Nearly two-third (61%) of the patients who participated in this study did not engage in physical activity for at least 30 minutes per two days of a week, with only 39% of the patients engaged in physical activity. Among the study participants, 67% patients had a current history of alcohol intake while 33% patients never took alcohol. More than three-quarter (89%) of the patients were consuming salty food and very few (11%) were restricted to use salt foods. Furthermore, the majority (82%) of the patients were non-smokers while few (17%) reported a current history of smoking.

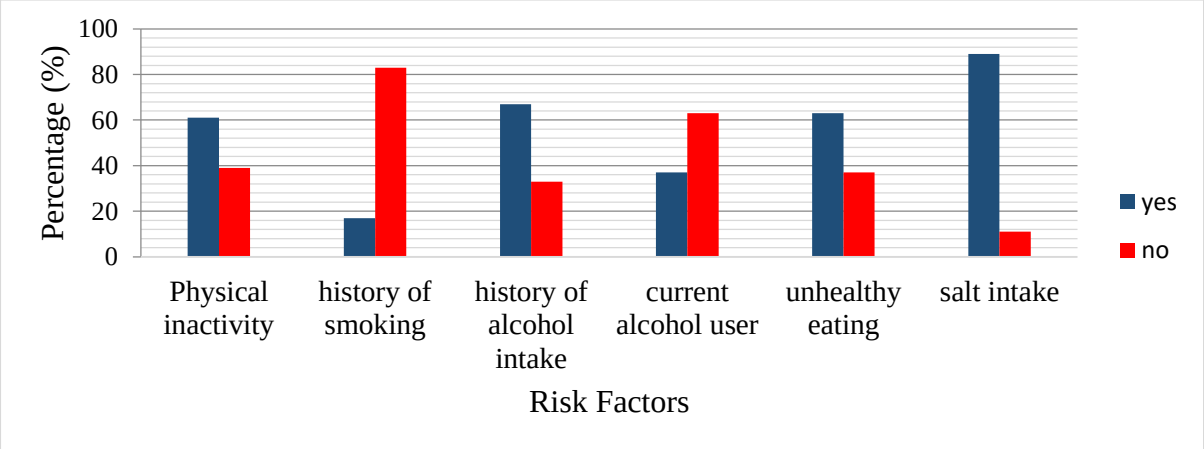

Figure 2: Profile of lifestyle risk factors among patients

(ii) Distribution of lifestyle risk factors for hypertension and coronary heart diseases by gender

Figure 2 shows the gender distribution of the lifestyle risk factors for hypertension and coronary heart diseases. With the exception of the history of smoking, female patients were more likely exposed to alcohol intake and physical inactivity than male patients.

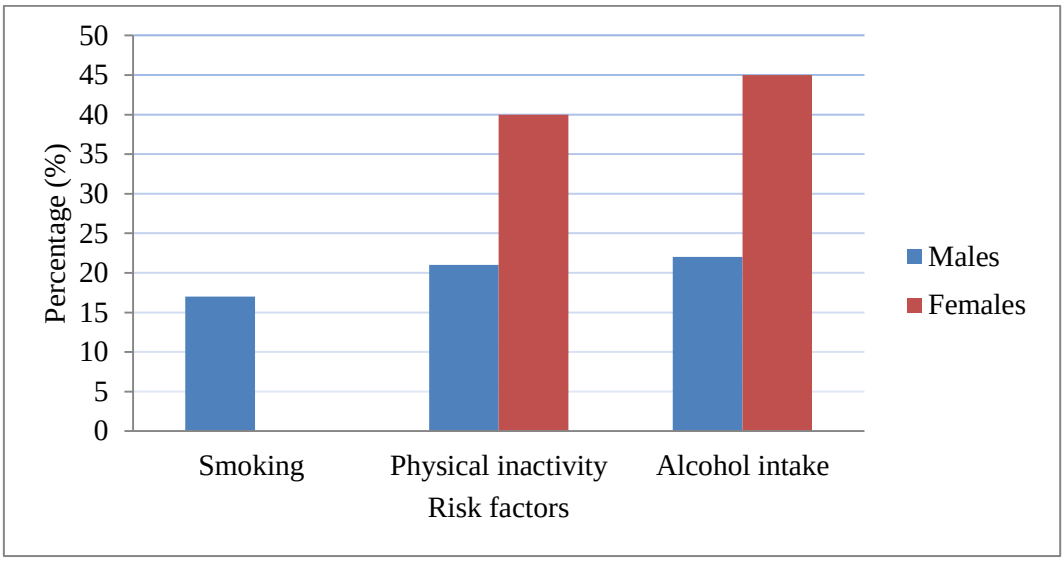

Figure 3: Gender distribution of lifestyle risk factors for hypertension and coronary heart diseases.

(v) Dietary habit of the patients

Dietary habits of the patients are presented in Fig. 4. The majority of the patients were consuming ≥ 3 servings/week of cereals (60%) and legume (36%) based foods. There was a low intake of fruits and vegetables among study patients. A large number of patients were consuming less than three serving of fruits and vegetable per week, with only 34% of patients consuming ≥ 3 servings of fruits and vegetables in more than 3 days/week.

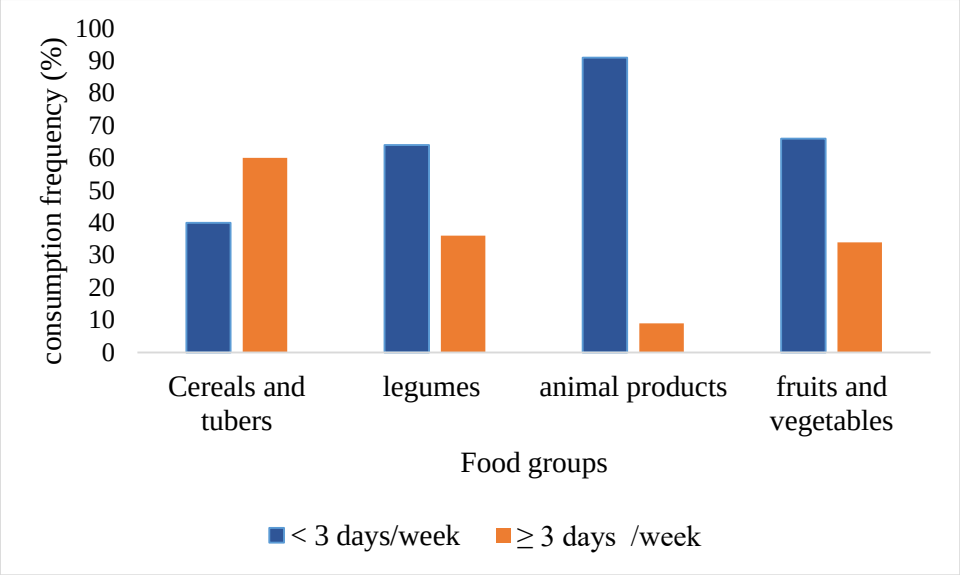

Figure 4: Patterns of dietary habits among study patients

4.1.4 Assessment of the blood pressure and nutritional status of the patients

(i) Assessment of blood pressure among patients

As shown in Table 2, more than half (59%) of patients were classified as hypertensive, 21% being stage I and 38% being stage II. Twenty-six percent (26%) of patients were pre-hypertensive, and 15% had normal blood pressure

Table 4: Distribution of blood pressure among study patients

Variable	Frequency	Percentage (%)
Blood pressure		
Normal (< 120/80)	15	15
Pre-hypertension (120-139/80-89)	26	26
Hypertension-stage I (140-159/90-99)	21	21
Hypertension stage II (≥160/≥100)	38	38

(ii) Assessment of the nutritional status of patients

Nutritional status of the patient was assessed through body mass index and the results are presented in Fig. 5. Only 25% of the patients had normal body weight, 36% were overweight and 39% were obese.

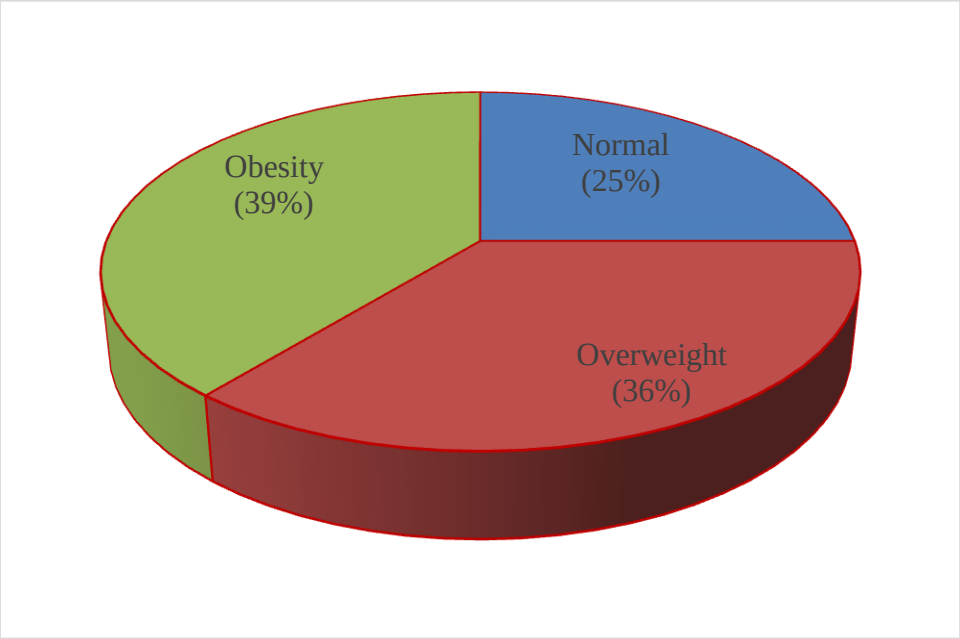

Figure 5: Prevalence of overweight and obesity among patients

4.1.5 Prevalence of biomarkers for hypertension and coronary heart diseases among study patients

High concentration of biomarkers for hypertension and coronary heart diseases were also recorded among study patients participated in this study. The most prevalent biomarkers found among patients were low-density lipoproteins (65%), C-reactive protein (60%), and alanine aminotransferase (40%) (Table 5). Furthermore, a higher concentration of serum sodium and potassium were also found among 41% and 40% of the study patients, respectively.

Table 5: Determination of biomarkers for hypertension and coronary heart diseases among patients

Biomarkers	Frequency	Percentage (%)
Plasma glucose (mmol/L)		
Normal (3.5-6.5)	67	67
Hyperglycemia/diabetes (> 6.5)	33	33
HDL-C (mmol/L)		
Normal (>1.45 to > 1.68)	21	21
Moderate risk(0.90 to 1.68)	50	50
High risk (0.90 to < 1.15)	29	29
LDL-C (mmol/L)		
Normal (< 2.59 to 3.34)	35	35
High risk (> 3.34 to ≥ 4.92)	65	65
ALT (IU/L)		
Normal- male (< 31)	25	25
Normal- female (< 19)	32	32
High risk – male (> 31)	6	6
High risk-female (> 19)	37	37
Sodium (mmol/L)		
Normal (136-145)	59	59
High (> 145)	41	41
Potassium (mmol/L)		
Normal (3.50 - 5.10)	60	60
High (> 5.10)	40	40
CRP (mmol/L)		
Normal (< 1)	22	22
Moderate risk (1-3)	18	18
High risk (> 3)	60	60

NOTE: ALT, alanine aminotransferase, CRP, C-reactive protein, LDL-C, low density lipoprotein cholesterol, HDL-C, high density lipoprotein cholesterol.

4.1.6 The association between socio-demographic characteristics, lifestyle, and biomarker/intermediate risk factors with hypertension and coronary heart diseases

Socio-demographic characteristics, lifestyle and intermediate risk factors studied in this study were associated with hypertension and coronary heart diseases and the findings were presented in Table 6. The association between gender, hypertension, and CHD were statistically significant at $p \leq 0.05$. Likewise, age showed a statistical association with hypertension and CHD ($p \leq 0.001$). There was no statistical association ($p \geq 0.05$) found

between education level, occupation with hypertension and coronary heart diseases among study patients. Furthermore, with the exception of smoking history, which showed significant association with hypertension and CHD ($p \leq 0.05$), physical activity, alcohol intake, blood pressure, and body mass index were not associated with hypertension and coronary heart diseases (Table 6).

Regarding biomarkers for hypertension and coronary heart diseases, plasma blood glucose, serum alanine aminotransferase, serum low-density lipoprotein cholesterol (LDL-C), serum high-density lipoprotein cholesterol (HDL-C), serum C-reactive protein (CRP), and serum potassium level were all positively associated with hypertension and coronary heart diseases at p-value ≤ 0.05 (see Table 6). There was no statistical association between sodium levels, hypertension and coronary heart diseases ($p > 0.05$) (Table 6).

Table 6: Association between socio-demographic, lifestyle risk factors, and biomarkers for hypertension and coronary heart diseases

Variables	**Diseases type**		**X^2-test**
	HTN (N = 65%)	**CHD (N = 23%)**	**p- value**
Socio-demographics			
Gender			
Males	22	9	
Females	43	26	0.007*
Age			
<45	4	15	
>45	61	20	0.000*
Education level			
HEL	9	5	
SEC	20	12	
PR	28	17	
NE	8	1	0.760
Occupation			
Formal employment	9	6	
Self-employed	45	27	
unemployed	11	2	0.614
Lifestyle risk factors			
Physical activity			
Yes	28	11	
No	37	24	0.350
History Smoking			
Yes	10	7	
No	55	28	0.040*
Alcohol consumption			
Yes	45	22	
No	20	13	0.764
Body mass index			
18.5-24.9 kg/m^2	12	13	
25-29.9 kg/m^2	25	11	0.352
≥30 kg/m^2	18	11	

Table 6 (continue)

Variables	Diseases type		X^2-test
	HTN (N = 65%)	CHD (N = 23%)	p- value
Blood pressure			
Normal	4	11	
Pre-hypertension	18	8	
Hypertension stage-I	16	5	0.086
Hypertension stage -II	29	9	
Bio markers			
Plasma glucose			
Normal	38	31	
Hyperglycemia/diabetes	27	4	0.004*
ALT			
Normal	43	14	
High risk	22	21	0.041*
HDL-C			
Normal	24	11	
High risk	41	24	0.016*
HDL-C			
Normal- males	8	0	
Normal -females	6	8	
Moderate-males	9	8	
Moderate-females	22	14	
High risk-males	6	3	
High risk-females	14	6	0.066
CRP			
Normal	18	4	
Moderate risk	12	6	
High risk	35	25	0.033*
Na			
Normal	38	21	
High risk	27	14	0.068
K			
Normal	39	21	
High risk	26	14	0.001*

* Values were statistically significant ($p \leq 0.05$), HTN, Hypertension, CHD, Coronary Heart Diseases, ALT, alanine aminotransferase, CRP, C-reactive protein, HDL-C, High-density lipoprotein cholesterol, LDL-C, Low-density lipoprotein cholesterol, Na, Sodium, K, Potassium

4.1.7 Determination of contributors of risk for HTN among patients

Results from Pearson Chi-Square (x^2) showed that gender, age, history of smoking, plasma blood glucose, alanine aminotransferase low-density lipoprotein, C-reactive protein, and potassium levels were significantly associated with HTN. However, when subjected to multinomial logistic regression only age, alanine aminotransferase and glucose were independently associated with HTN risk (Table 7).

Moreover, the association between age and HTN risk was significant. Those patients aged < 45 years (OR = 0.17, CI = 0.047-0.612) were at more risk for hypertension than those aged > 45 years. Moreover, those with normal ALT had a lower risk for hypertension (OR = 3.24, CI = 1.22-8.57) than those with higher ALT levels. Further results showed a significant

association between HTN risk and blood sugar, and patients with normal blood sugar (OR = 0.22, CI = 0.62-0.76) had reduced risk for hypertension than diabetic patients.

Table 7: Results from multinomial logistic models to determine significant predictors of hypertension

Variable	Parameter Estimated (B)	Standard error	P-value	OR / Exp (B)	95% CI of OR
Age					
<45	-1.78	0.66	0.007	0.17	0.047-0.612
>45	Reference				
ALT					
No risk	-1.18	0.49	0.018	3.24	1.22-8.57
Risk	Reference				
Glucose					
Normal	-1.53	0.64	0.016	0.22	0.62-0.76
Hyperglycemia/diabetes	Reference				

NOTE: ALT, Alanine aminotransferase

4.1.8 Determination of contributors for CHD risk among patients

As shown in Table 8, the association between CHD risk and age was statistically significant (P = 0.002). Patients aged < 45 years were almost four times at high risk for suffering from CHD (OR = 9.82, CI = 2.37-40.62) compared to those aged > 45 years. The risk for CHD was higher among patients with high ALT levels compared to those with normal ALT levels (OR = 0.34, CI = 0.12-0.93). Compared to patients with normal blood sugar (OR = 4.77, CI = 1.31-17.42), those patients with high ALT levels were more likely to suffer from CHD. Further results showed that patients with normal CRP (OR = 0.25, CI = 0.08-0.79) had reduced risk for CHD compared to those with higher CRP levels.

Table 8: Results from multinomial logistic models to determine significant predictors of coronary heart diseases

Variable	Parameter Estimated (B)	Standard error	P-value	OR / Exp (B)	95% CI of OR
Age					
<45	2.28	0.72	0.002	9.82	2.37-40.62
>45	Reference				
ALT					
No risk	-1.09	0.52	0.035	0.34	0.12-0.93
Risk	Reference				
Glucose					
Normal	-1.56	0.66	0.018	4.77	1.31-17.42
Hyperglycemia/diabetes	Reference				
CRP					
Normal	-1.38	0.58	0.018	0.25	0.08-0.79
High level	Reference				

NOTE: ALT, Alanine aminotransferase, CRP, C-reactive protein

4.2 Discussion

The current study provides an overview of prevalence of CVDs risk factors among patients diagnosed with CHD and HTN attending the cardiac clinic at a referral hospital in Tanzania. Findings from the current study showed higher prevalence of HTN and CHD, with higher proportion of patients being exposed to CVDs risk factors despite the fact that they were under clinical management. To date, there were only two studies (Kitange *et al.,* 1993; Swai *et al.,* 1993) conducted in Tanzania as related to CHD and their associated risk factors. These studies have reported a lower prevalence of CHD and their associated risk, contrary to the current findings which showed a higher prevalence of CHD and their associated risk factors. This might be due to the fact that the present study was conducted at a hospital setting and all patients involved had known medical conditions (HTN and CHD). Furthermore, results from this study reflect the current growing trend of CVDs, which is characterized by changes in lifestyle and epidemiological transition within the country (Blomstedt *et al.,* 2012).

4.2.1 Lifestyle risk factors

Results from this study present a higher prevalence of the lifestyle risk factors among study patients. More than two-third of the patients who participated in the study were physically inactive, with female patients being more inactive than male patients. Low level of physical activity among patients has been related to aging, cardiovascular symptoms and other chronic diseases such as arthritis that reduces walking ability. The general health condition of the patients, shortage of breath, fatigue, and weakness have been reported as factors that lower levels of physical activity among patients with CHD (Press *et al.,* 2003; Stewart *et al.,* 2013). Percentage of physically active patients in this study were higher compared to 17% reported from the National Health and Nutrition Examination Survey 2007-2010 (Tang *et al.,* 2013). As reported by Darden *et al.* (2014) patients with established risk of CHD have significant benefits from regular physical activity, and patients should be well encouraged to engage in any physical activity for the improvement of general health condition.

All patients in this study were using drugs for treatment of HTN and CHD, and more than two-third of them had a current history of alcohol intake. Patients with history of alcohol intake were more affected with HTN and CHD than non-alcohol users. This is may be due to contribution of alcohol in the formation of atherosclerosis and thrombotic lesions (Mukamal and Rimm, 2001) that worsen the diseases and overall health condition of the patients. The overall prevalence of alcohol consumption was higher compared to 20% prevalence of

alcohol reported from the National Health and Nutrition Examination Survey (Tang *et al.*, 2013), 17.2% by Mbatia *et al.* (2009) and 20% in the rural and 22% in urban setting of Tanzania Francis *et al.* (2015). This finding suggests lower level of knowledge on the effects of alcohol intake on the overall health status and reduction of drug efficacy and efficiency. This may also reduce the rate of recovery from the disease and may result in more health complications (Conen, 2015).

Furthermore, only 17% of the patients were smokers, and all were males similar with that reported in the EUROASPIRE III survey carried out in 2006-2007 in 76 centres from selected geographical areas in 22 countries in Europe (Kotseva *et al.*, 2009). Compared to previous findings in the country, the proportion of smokers in this study were lower than that reported by Bovet *et al.* (2002) (27% in men and 5% in women), Jogoe *et al.* (2002) 26% and 2.9% in men and women, respectively. This study presumes that the lower prevalence of smoking among patients was associated with few numbers of patients involved in the study.

4.2.2 Dietary habits of study patients

The main food source consumed by the study participants were cereals and tubers based foods along with legumes. Consumption of legumes has been recognized to reduce the effect of heart diseases especially CHD, due to the high content of protein and water-soluble fiber which counteract the effect of serum cholesterol (Bazzano *et al.*, 2001). Consumption of cereal-based food is of great importance as it contains dietary fibers and other potentially cardio-protective components, which reduce total cholesterol and improve glycemic control in diabetic patients (Truswell, 2002; Mann, 2007). Patients should be encouraged to eat unprocessed cereals-based foods since processed cereals have reduced nutrient contents and bio-protective substances. Consumption of animal foods and their products were moderate, however, few patients reported intake of more than 3 servings of fruits and vegetables per week and this might contribute to the higher levels of blood cholesterol observed to the patients. Majority of the patients were consuming less than 3 servings of fruits and vegetables per week and this has been related with low knowledge on the importance of consuming fruits and vegetables and the protective effects of the nutrients on the prevention and reduction of heart diseases.

4.2.3 Blood pressure and nutritional status of patients

Despite that all patients were receiving drugs for treatment and control of HTN and CHD, majority of them had uncontrolled blood pressure. The results showed 59% of the patients

had uncontrolled blood pressure (systolic blood pressure ≥ 140 mmHg and diastolic blood pressure ≥ 90 mmHg, contrary to 50% prevalence of uncontrolled blood pressure reported among patients suffering from CHD in EUROASPIRE II Heart Survey Programme (Kotseva *et al.*, 2001). These findings were inconsistent with that reported in hospital hypertension unit-Spain by Banegas *et al.* (2004) which found only 42% of the patients had to achieve the targeted goal of lowering blood pressure. The current prevalence of hypertension was almost similar with 57% by (Njelekela *et al.*, 2009) and lower compared to 37% prevalence of HTN shown by Zack *et al.* (2017) in the studies conducted in Dar es Salaam. Higher levels of blood pressure among patients might be related with higher consumption of dietary salt (89% of patients) and use of hypertensive drugs that have been reported to contribute to the metabolic effects of thiazide to CHD risk (Olafiranye *et al.*, 2011). Dietary salt does not only increase blood pressure but also causes endothelial dysfunction, albuminuria, and development of kidney disease (Kristal *et al.*, 2014). Control of blood pressure is more important than the choice of anti-hypertensive drugs in the prevention of CHD and other CVD events.

On the other hand, more than one-third of the participants were overweight (36%) and obese (39%), respectively. This has been related to the lower level of physical activity and poor eating habits characterized by low consumption of fruits and vegetables among study participants. The prevalence of overweight and obesity found in this study is likely to worsen the health status of the patients as it increases other CVD risks (Kotseva *et al.*, 2001). The current prevalence of overweight and obesity was lower compared to that reported in Egypt (overweight 44% and obesity 36%) and Ghana (overweight 30%, obesity 32%) (Amugsi *et al.*, 2017). Health interventions focusing on a healthy diet, physical exercise, and weight management are urgently needed to rescue patients from other health complications.

4.2.4 Biomarkers for hypertension and coronary heart diseases

Results from this study revealed substantial higher levels of studied biomarkers for both HTN and CHD among study participants. These biochemical markers are also regarded as intermediate risk factors for CVDs as revealed in the literature review.

The proportion of abnormal LDL-C and HDL-C was significantly higher in the study population, particularly among women, and this has been linked to lifestyle changes. Findings from this study correspond with other study findings that showed higher proportions of LDL-C and lower HDL-C levels among women (Njelekela *et al.*, 2009; James, 2013).

Higher consumption of animal foods (meat, milk, and eggs), low intake of fruits and vegetables, low physical activity are among the factors that can contribute to the higher serum cholesterol among study participants.

In the current study, one-third of the patients had uncontrolled blood sugar, which was lower compared to 87% of the patients with higher (> 6 mmol/L) plasma glucose reported in the EUROASPIRE II Heart Survey (Kotseva *et al.,* 2001). The overall prevalence of diabetes in the current study was higher compared to 21.7% reported in Kilimanjaro region by Stanifer *et al.* (2016) and 5% and 2% found in urban and rural Tanzania, respectively (Aspray *et al.* 2000). For diabetic patients, blood pressure should be treated to > 80 mmHg in order to reduce other health complications (American Diabetes Association, 2003).

Majority of the patients who participated in the study had elevated levels of serum electrolyte (sodium > 145 mmol/L and potassium > 5.10 mmol/L) and this was linked with higher salt intake observed among patients. Similar finding was previously reported from 5-years follow-up study, which found higher levels of K (≥ 4.80 mEq/L) in the group of hypertensive patients and lowest level of serum K (4.40-4.59 mEq/L) among the control group (Xi *et al.,* 2015). High consumption of salty foods and antihypertensive drugs can block the renin-angiotensin-aldosterone system, thereby impairing kidneys ability to excrete potassium. Dietary diversification has been linked with serum K and Na levels. For example, unprocessed foods including beans and peas, nuts, vegetables such as spinach, cabbage and parsley and fruits, such as bananas, papayas, and dates are good sources of K and Na.

Furthermore, higher levels of ALT were recorded among patients, with females (37%) being with higher ALT levels of > 19 IU/L compared to 6% with > 31 IU/L of males. This might be related to alcohol consumption, insulin resistance, obesity and other chronic diseases such as renal diseases that influence the synthesis of ALT in the liver (Ioannou *et al.,* 2006). The present findings were similar to that documented in the cross-sectional analysis conducted in the United States (Ioannou *et al.,* 2006) of which 267 CHD patients had > 42 IU/L ALT levels. The findings herein are contrary to 12% of the patients found with higher ALT concentration in a study conducted in a primary care setting in central Virginia from 2010 to 2011 (Siddiqui *et al*., 2014).

Further findings showed that, more than three-quarters of the study patients (77%) were found with higher CRP levels and the burden of HTN and CHD increases with high CRP

levels. Similar findings were reported in a Framingham Heart Study by Wilson *et al.* (2005) and by Arima *et al.* (2008) on the Hisayama study. Higher levels of CRP observed in this study have been associated with a higher prevalence of smoking, obesity, and aging and, the presence of other chronic diseases.

4.2.5 The association between socio-demographics, lifestyle risk factors, nutritional status, and biomarkers with hypertension and coronary heart diseases

Factors that were found to have an association with HTN and CHD in this study were: Age, Alanine aminotransferase, diabetes, and C-reactive protein. Patients aged < 45 years had reduced risk of being hypertensive than patients aged > 45 years. However, in this study, the onset of coronary heart diseases seem to develop early among patients aged < 45 years than those aged > 45 years. This might be related with rapid urbanization, sedentary lifestyle, and adoption of westernized dietary habits. (Milane *et al.*, 2014; Katalambula *et al.*, 2017).

The association between ALT, HTN, and CHD observed in this study was similar with that reported by Goessling *et al.* (2008) and Adibi *et al.* (2007) in their studies. Patients with higher concentration of ALT had higher risk of hypertension and CHD than patients with normal ALT levels (Goessling *et al.*, 2008). Interventions aimed at reducing elevated ALT levels to normal may help to slow down the process of atherosclerosis. Furthermore, preventive strategies should be monitored at least partly by using liver function test.

The association between CRP, HTN, and CRP was observed in the current study, similarly with findings from other related studies (Cesare *et al.*, 2008; Kaptoge *et al.*, 2010; Dong *et al.*, 2014). Moreover, findings from epidemiological data also show an association between higher CRP levels and future CVD morbidity among patients with known CHD (Danesh, 2005; Zakynthinos and Pappa, 2009), similar with what was observed in the current study.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

This study provides insight into the management of hypertension and coronary heart diseases among patients visiting the cardiac clinic at KCMC referral hospital in Kilimanjaro region. The study revealed higher prevalence of both lifestyle risk factors and related biomarkers for hypertension and coronary heart diseases among patients, despite the fact that the patients were under clinical management. This may indicate inadequate management of these risk factors among patients visiting the cardiac clinic, including lack of education on life style risk factors for CVDs among population. Poor management and monitoring of these risk factors can delay treatment outcome and leading to more health complications, like stroke, which will increase health cost of treatment and management at individual and population levels. Lifestyle modification, of especially healthy food choice and increased physical activity provides preventive measures in reduction and prevention of CVDs. Furthermore, evidence from this study demonstrated a key role played by inflammatory markers, particularly CRP and ALT, in the pathogenesis of cardiovascular diseases, which calls for further mechanistic studies involving the two biomarkers. Regular checkup, education and monitoring of both lifestyle risk factors and biomarkers for CVDs, should be carried among patients with CHD and HTN will help in their management both at hospital levels and population levels.

5.2 Recommendations

(i) Study results herein call for sensitization programs, to include more interventions, such as health education on lifestyle risk factors in order to raise patients' awareness of lifestyle modification including proper healthy eating. Apart from drug therapy, lifestyle advice should be well structured and tailored to all patients with cardiovascular diseases based on their individual needs.

(ii) Regular checkup and monitoring of both lifestyle risk factors and biomarkers for CVDs in patients with HTN and CHD will help in improvement of their management and establishment of appropriate interventions.

(iii) This study recommends for a larger prospective study with larger sample size and long-term follow-up, to evaluate management outcomes among patients visiting cardiac clinics.

(iv) The study also recommends for placement of nutrition officers/dietitians in Tanzanian hospitals by the Government, to provide education on physical activity and dietary counseling to the CVD patients, as one of the key strategy in their management.

5.3 Limitations of the study

The following were the limitations in this study:

(i) Lack of enough financial resources, which led to limited chemicals and reagents, which limited the number of study participants.

(ii) However, despite the obvious limitation, this study provides important novel insights on the need to improve CVD management in Tanzania context.

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APPENDICES

Appendix 1: List of chemical and reagents

Name of the chemical/reagent	Manufacturers
ISE Reference Electrolyte cobas Integra (250mL):	Roche Diagnostics GnbH Sandhofer Strasse 116, D-68305 Mannheim, Germany.
ISE Calbrator indirect cobas integra (250mL): 150 mmol/l of Na^+, 5 mmol/l of K^+, 0.3 mmol/l of Li^+, 115 mmol/l of Cl.	Roche Diagnostics GnbH Sandhofer Strasse 116, D-68305 Mannheim, Germany.
MAGLUMI CRP (CLIA): Nano magnetic microbeads (2.5 ml), Calibrator low (2.5 ml), Calibrator high (2.5 ml), FITC Label (12.5 ml), ABEI Label (22.5 ml), Diluent (25.0 ml) and 2.0 ml of Internal Quality Control.	Shenzhen New Industries Biomedical Engineering Co., Ltd. (snibe). 4/F, Wearnes Tech Bidg, Science &Industry Park, Nanshan, Shenzhen,518057 China
Alanine aminotransferase COBAS INTEGRA/cobas C system: **R1:** TRIS buffer: 224 mmol/L, pH 7.3 (37oC); L-alanine: 1120 mmol/L; albumin (bovine): 0.25%; LDH (microorganisms): > 45 ukat/L; stabilizers; preservative **R2:** 2-Oxoglutarate: 94 mmol/L; NADH: > 1.7 mmol/L	Roche Diagnostics GnbH Sandhofer Strasse 116, D-68305 Mannheim, Germany.
COBAS Integra 400 Plus Glucose HK Liquid-800 tests: R1 MES buffer: 5.0 mmol/L, pH 6.0; Mg2+: 24 mmol/L; ATP: > 4.5 mmol/L; NADP: > 7.0 mmol/L; preservative R2 HEPES Buffer: 200 mmol/L, pH 8.0; Mg2+: 4 mmol/L; HK (yeast): > 3 00 ukat/L; G-6-PDH (E.coli): > 300 ukat/L; preservative.	Roche Diagnostics GnbH Sandhofer Strasse 116, D-68305 Mannheim, Germany.

Appendix 2: List of equipments

Name of the equipment	Manufacturer
Neogloves	Neomedic limited, Great Glove (Thailand) Co., Ltd
Neoject Non-Pyrogenic Auto Disable Syringe with Needle	Neomedic Limited, China
Microvatte tubes, Eppendorf tube	Neomedic Limited, China
Vortex mixer	Germany
stadiometer	Leicester stadiometer
Weighing scale	Seca Germany
Automatic digital sphygmomanometer (PB machine)	(Life Brand™ BM60)
Centrifuge machine (3,000 rpm)	Made in Germany
Cobas integra 400 analyzer plus	Roche Diagnostics GnbH Sandhofer Strasse 116, D-68305 Mannheim, Germany
Maglumi 800 analyzer	Shenzhen New Industries Biomedical Engineering Co., Ltd. (snibe) 4/F, Wearnes Tech Bidg, Science and Industry Park, Nanshan, Shenzhen,518057 China

Appendix 3: Questionnaire sheet

Overview of the study

Am conducting a study in your region with the aim of establishing the association between lipids, ALT, CRP and sodium/ potassium levels, nutritional status and food habits among cardiovascular diseases patients in Kilimanjaro region-Tanzania. Am requesting you to provide with correct information which will be very important towards implementation of right diagnosis methods and to design intervention with the implications of reducing and preventing cardiovascular diseases in the community. I promise that the information you provide will be preserved with highest confidentiality.

Do you agree to proceed with the interview? [] Yes [] No

Kindly am requesting you to fill the gap below with correct information

Questionnaire Part 1: Information on socio-demographics, behavioral and intermediate risk factors of the patients

Questions	**Response**
Socio-demographic characteristics	
Patient ID	
Sex	
Age (Year of birth)	
Education level	
Marital status	
Occupation	
Anthropometric measurements	
Body weight (Kg)	BMI
Height (m)	
Blood pressure measurement	
Systolic	1. 2.
Diastolic	1. 2.
Behavioral risk factors	

Physical Activity	
In a typical week, how many days do you perform vigorous-intensity activities as part of your work?	1. Yes 2. No
How much time do you spend doing vigorous-intensity activities at work on a typical day?	1. < 30 minutes 2. 30 minutes
If yes which kind of physical activity do you usually perform?	1. Walking 2. Gardening 3. Running 4. Others, mention
Alcohol consumption	
Have you ever consumed an alcoholic drink such as beer, wine, spirits, fermented cider	1. Yes 2. 2. No
Have you consumed an alcoholic drink within the past 2 months?	1. Yes 2. No
If yes, please mention the type of alcohol	1. 2. 3.
Smoking	
Do you currently smoke any tobacco products, such as cigarettes, cigars or pipes?	1. Yes 2. 2. No
In the past, did you ever smoke daily?	1. Yes 2. 2. No
Dietary factors	
In a typical week, on how many days do you eat fruit?	Number of days
How many servings of fruit do you eat on one of those days?	Number of servings
In a typical week, on how many days do you eat vegetables?	Number of days
How many servings of vegetables do you eat	Number of servings

on one of those days?	
History of chronic diseases	
Have you ever had any history of heart diseases	1. Yes 2. 2. No
If yes, please mention the type of diseases	1. Hypertension 2. Coronary heart disease
Do you have any other chronic diseases than hypertension and coronary heart diseases	1. Yes 2. 2. No
If yes, please mention the name of the disease(s)	1. 2.
Do you have any relative who have suffered from hypertension and coronary heart disease or any other heart disease?	1. Yes 2. No
Relation with this relative? Eg. Father	
Which condition are they suffering from?	
Alternative medicines	
Are you using any herbal medicine for treatment of coronary heart disease and hypertension/any other diseases?	1. Yes 2. No
If yes, please mention the name(s) of the herbal medicine you usually use for treatment of coronary heart disease and hypertension/any other disease	
Where do you found these herbal medicines?	
Who advised you to use those herbal medicines	

Questionnaire part II: Dietary practices/Food frequency questionnaire

Below is a table that contains a list of different types of foods, you are requested to put a (**V**) mark in the correct column to show how many times you usually eat these foods.

Food frequency questionnaire for 1 week

List of foods		**Never**	**Once**	**Twice**	**3 Times**	**>3 times**
a) MAIN STAPLES						
Banana						
Maize						
Rice						
Cassava						
Yams						
Sweet potatoes						
Mention if there is any other staples that is not in a list above	1.					
	2.					
	3.					
b) LEGUMES						
Cooked cowpeas						
Cooked beans						
Soya beans						
Pigeon peas						
Mention if there is any other legumes that is not in a list above	1.					
	2.					
	3.					
c) FOODS OF ANIMAL ORIGIN AND ITS PRODUCTS						
Beef						
Goat meat						
Sheep meat						
Pig						
Poultry						
Milk						
Cheese						
Eggs						
Fish						
Mention any other foods of	1.					

animal origins	2.					
	3.					
d) **FRUITS AND VEGETABLES**						
Amaranth						
Spinach						
Nightshade						
Avocado						
Ripe Banana						
Mango						
Pineapple						
Watermelon						
Pawpaw						
Oranges						
Mention if there is any other fruits and vegetables	1.					
	2.					
	3.					
e) **BEVERAGES**						
Fresh fruits juice						
Artificial juice						
Soda						
Coffee						
Black tea						
Bear						

Appendix 4: Informed consent

THE NELSON MANDELA AFRICAN INSTITUTION OF SCIENCE AND TECHNOLOGY (NM-AIST)

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TITLE: ASSESSMENT OF BIOCHEMICAL MARKERS AND THEIR ASSOCIATION WITH CARDIOVASCULAR DISEASES IN PATIENTS FROM KILIMANJARO REGION

CONSENT FORM: Please read the following to the respondent precisely.

You are being asked to take part in a research study on "**Assessment of Lifestyle Risk Factors Among Cardiovascular Disease Patients Attending Kilimanjaro Christian Medical Centre in Tanzania**". We are asking you to take part in this study because you fit in the set criteria. Please listen carefully and ask any questions you may have before agreeing to take part in the study.

What the study is about: The purpose of this study is to establish an association between lipids, ALT, CRP, glucose, and sodium (Na)/ potassium (K) levels, nutritional status and food habits among CVD patients in Kilimanjaro region-Tanzania.

What we will ask you to do: If you agree to participate in this study, we will ask you some questions about your daily dietary intake, we will collect 10ml of your blood for analysis of blood cholesterol, alanine aminotransferase, C- reactive protein, blood glucose, sodium, and potassium levels, weight and height measurements and other questions about your family history, results will be given to you.

The survey will take about 45 minutes to complete. We may contact you again in the future to follow up on how you are doing.

Risks: There is the risk that you may find some of the questions about your dietary habits to be sensitive.

Benefits: Immediately, you will get to know your blood test results and in a longer-term this is beneficial in improving diagnostic methods, to plan and design an appropriate intervention for prevention and control of cardiovascular diseases especially coronary heart diseases and hypertension to the whole community.

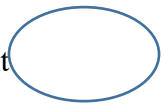
Compensation: There is no compensation for taking part in this study.

Confidentiality: Your answers will be confidential. The records of this study will be kept private. In any sort of report, we make public we will not include any information that will make it possible to identify you. Research records will be kept in a locked file; only the researchers will have access to the records.

Taking part is voluntary: Taking part in this study is completely voluntary. You may skip any questions that you do not want to answer. If you decide not to take part or to skip some of the questions, it will not affect your current or future relationship with the researcher or Nelson Mandela African Institute of Science and Technology, the District or Regional Council. If you decide to take part, you are free to withdraw at any time.

If you have questions: The researchers conducting this study: Wilfrida Roman email: romanw@nm-aist.ac.tz Phone: 0762689277

Statement of Consent: I have read the above information, and I consent to take part in the study.

Participant Name: ……Date:……. Signature:…….. Thumbprint 

Witness name:……Date:……. Signature ……

Name (Researcher): ……Date: …….. Signature: …….